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MITIGATING CLIMATE CHANGE THROUGH THE AVAILABILITY AND UTILIZATION OF LIQUIFIED PETROLEUM GAS (LPG) FIRED BAKING OVEN, IN ENUGU STATE.

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Abstract

The study examined the extent of availability and utilization of Liquefied Petroleum Gas (LPG) Fired Baking oven in Enugu. A total number of 447 registered confectionery bakers in Enugu, comprising 343 urban and 104 rural bakers were studied. Survey research method was used for the study. The instrument used for data collection was a structured questionnaire. Two research questions and two null hypotheses guided the study. The instrument for Data collection was subjected to face validation by three experts. The reliability of the instrument was established using the test-retest method with 30 bakers from Ebonyi state. The overall reliability coefficient using the Spearman's rank order coefficient formular yielded 0.89. Data analyses were done using Mean and Standard deviation. While t-test statistical tool was used to test the hypotheses, at 0.05 level of significance; this was to establish if significant difference(s) existed between the urban and rural bakers in the extent of availability and utilization of the Liquefied Petroleum Gas (LPG) fired baking oven in Enugu state. The result showed that significant difference did not existed in respect of the availability of the LPG fired baking oven between the bakers in urban and rural areas of Enugu state. On the other hand, the result showed that significant difference existed in respect of the utilization of the LPG fired baking oven between the bakers in urban and rural areas of Enugu state. In conclusion, there is an urgent need for a paradigm shift in using less efficient firewood fired ovens which continually cause the degradation of the vegetation thus exposing the environment to adverse climatic effects. The researcher therefore recommended a stiff penalty against gas flaring which must be backed up with enforceable legislation. Secondly, there is need to aggressively commercialize LPG distribution outfits with an appropriate government regulatory agency to oversee the activities of the gas distribution companies.

Keywords

Availability, Utilization, Liquefied Petroleum Gas, Baking Oven, Adverse Climatic Effects, Paradigm Shift, Gas Flaring.

Introduction

Background of the Study

Energy is a very essential aspect of man's everyday needs. Several sources of energy are available for diverse domestic and industrial uses. Two major sources of energy are available, renewable and nonrenewable energy sources. The nonrenewable source of energy is the focus of this study with particular consideration of petroleum gas liquids. It is a clean source of energy with substantially very high calorific value. Unfortunately, large volumes of liquefied petroleum gas in energy is wasted by gas flaring during oil drilling activities.

The Nigerian National Petroleum Corporation (NNPC), Sunday, 26th June, 2017 stated that Nigeria's revenue would grow significantly if a law prohibiting gas flaring by oil and gas companies operating in Nigeria is enacted. Unfortunately, Nigeria accounts for 40% of gas flared annually in Africa (Nigeria 8th Senate), which amounts to about

$7 billion in waste.

Gas flaring in Nigeria, pitiably in the words of the Deputy Majority Leader of Nigeria's Senate, Senator, Bala Ibn Nallah declaring open the public hearing on behalf of the Senate President – Bukola Saraki said the issue of gas flaring was a matter of great national embarrassment adding that the 8th Senate was committed to enacting a legislation that would end gas flaring in the country. Due to unsustainable exploration practices, coupled with the lack of gas utilization infrastructure, Nigeria flares more than 75% of gas produced and re-inject only 12% to enhance oil recovery (Bassey, 2017). Coupled with it's climatic and environmental degradation effects, the Liquified Natural Gas (LPG) can be converted into energy source.

For now, this poses a special problem to the country's oil and gas industry as well as researchers in the country. The unfortunate apparent intractable trend prompted this study.

Gas Flaring In Nigeria

Gas flaring has impoverished the communities where it is practiced, with attendant environmental, economic and health challenges. These difficulties faced by the local communities from gas flares are sufficient justification for ending gas flaring practices. Fines by defaulting companies should be so exorbitant so as to deter them, while the gas can be processed and produced into cooking/domestic gas(Ajuwo, 2013). Nigeria flares 17.2 billion m^3 of natural gas per year in conjunction with the exploration of crude oil in the Niger Delta(Ajuwo, 2013).

Acid rains have been linked to the activities of gas faring(Friends of the Earth, 2004 & Medilinkz, 2010 in Ajuwo, 2013). Corrugated iron roofing sheets in the Niger Delta region have been corroded by the composition of the rain that falls as a result of gas flaring. The primary of acid rains are emissions of Sulphur dioxide(SO_2) and Nitrogen oxide(NO) which combine with atmospheric moisture to form Sulphuric acid($H_2 SO_4$) and Nitric acid(HNO_2), respectively(Hassan & Konhy, 2013 in Ajuwo, 2013).

Review of Related Literature

Concepts of Baking:

Baking refers to a process "to cook by dry heat" and is therefore next to cooking, another essential way of preparing food from raw staple crops. During the baking process the dough is transformed into eatable food (nutritional improvements) and at the same time, microorganisms causing spoilage are destroyed prolonging keeping time of the product (food preservation). Unlike other cooking methods, baking does not alter the nutritional value of the food item, e.g. the fat and calorie content of the food (Spritzler, 2019).

Usually, baking takes place in an oven or on a hotplate, but also in hot ashes or on hot stones. During baking, the heating process is done by a combination of three forms of heat: by infra-red energy that is radiated from oven walls, by circulating hot air; and by conduction through the baking pan or tray(Fellows & Axtell, 2004). That means the efficiency of the baking process depends on the optimal use of three different parts of the device: the walls, the tray and the ventilation system.

Burning biomass within the device produces the desired heat. Subsequently, the confectionaries are placed inside and are baked for a certain amount of time. In the simplest way, a fire is lighted in a pit on the ground and after being burned down, the covered food is started to be baked (earth oven). Whereas for the Liquefied Petroleum Gas(LPG) oven, the burners are lighted and the heat so generated is distributed through the piping of the oven without any risk of contaminating the product.

Bread doughs produced from wheat flour have a unique viscoelasticity due to the wheat protein gluten, and therefore provide a better nutrition for humans. The world production of wheat in 2010 was 651 million tons, topped only by the cereals maize and rice. At the beginning of this century, more than 45 per cent of the world's wheat was produced in developing countries(Curtis, 2002). Bread is widely eaten in Africa by both urban and rural communities. The major challenge with bread consumption in Africa is that most countries can't produce sufficient quantities of wheat to supply the bread market. Therefore, other starchy materials such as corn, potato, banana, yam, rice, sorghum, or cassava substitute wheat(Bokanga & Tewe,2008).

Bakery

Bakeries exist worldwide in all sizes in both the formal and the informal sector: Small bakers operating from home, retail bakers who operate in-store bakeries, independent bakers who operate stand-alone bakeries, and large wholesale bakers who operate industrial (plant) bakeries. In many regions the industry, which is often dominated by small and micro enterprises, are often facing

unfavourable conditions, such as lack of baking supplies, lack of access to efficient baking technologies and credit options to finance the investment (Bali, 2018).

For the survival and sustenance of this industry it is important to have the following factors in place(Dagoon, 2005):

- abundant supply of wheat flour or its alternatives
- efficient baking technologies
- capital at low interest rate
- quality control of the products
- continuous demand for bakery products
- access to good transportation and communication
- effective promotion
- Ingredient inspection
- Quality assurance of bakery products
- Process control in a bakery involves accurate weighting of ingredients, control over baking temperatures and times and correct handling procedures for products. This includes also an optimal usage and handling of the chosen technology and energy fuel.
- Cleaning routine to ensure hygienic standards.

Baking requires very high temperature and thus needs a larger amount of thermal energy input. Due to the lack of electricity, biomass energy is mostly used for baking in developing countries. Efficient baking technology has a high potential to reduce the firewood consumption, guaranteeing not only an efficient and shorter baking process, but also reduced operating costs.

Ovens

The most important device in a bakery is the oven. Before obtaining an oven, a baker should consider oven prices, fuel availability and affordability, possible assistance, supply and quality of the materials, maintenance requirements, etc.

Traditional Ovens

The simplest way is to bake within a so-called earth oven: after a lighted fire in a pit on the ground is burned down, the food is put inside the pit and covered: the baking process starts. Other traditional baking ovens consist of a baking chamber made of fire-proof brick, concrete, stone, clay, or cob. Traditionally they are wood-fired, but coal-fired ovens are also common. It is known as a "black oven" because the smoke from the burned wood emits soot on the roof of the oven. Traditional ovens often lack insulation and proper ventilation. They consume in average more than 0.5-1 kg of wood per kg of baked wheat flour(Armando, Lucas, & Richards,2012).

Improved Ovens

Two types of improved ovens are in common use worldwide: direct heating ovens heated by fuels in the baking chamber and indirect heating ovens that have a separate heater or firebox. Both types are constructed from materials such as steel, which withstands high temperatures(UNIDO, 2004).

Indirect Heating Ovens

Indirect heating ovens can be operated continuously at constant temperatures because the fire can be maintained without interrupting production. The simplest oven designs have a separate firebox with brick or tile-lined flues surrounding the baking chamber. Both types of oven can be found in various sizes and with varying capacities. The heat should be evenly distributed throughout the baking chamber and all parts of the chamber should be easily reached through the oven door so that products can be loaded/unloaded without the risk of burns.

Experience show that improved ovens reduce firewood consumption significantly – up to 50-80% compared to a traditional oven.

Fuels

Theoretically, anything that burns can be used to heat a baking oven, but in practice, fuel needs careful selection. It is not always best to choose the cheapest energy source in order to be economical. Other factors should be considered such as, the consistent availability of fuel, the type and amount of ash that is formed, the energy value of the fuel and the location of the bakery to prevent smoke disturbances.

Baking requires a larger amount of thermal energy input than cooking. Availability and price of fuel are therefore crucial for bakeries as it constitutes their largest operating cost: up to 30 per cent of the bread loaf cost is constituted by fuel costs(Fellows, 2012 and Lawson, & Joseph, 2009). Bakers must therefore conduct a careful analysis of their energy needs.

The following fuels may be available:

- Mains gas or bottled gas (LPG) are the preferred options in countries that have an

established gas distribution system because they burn cleanly, regulation of heat input is possible instantly, and produce no contamination of products. In some regions gas may be too expensive, and it may be available only in some urban centres.

- Electricity is mostly a question of availability and afordability.
- Solid fuels may be the lowest-cost option in many countries. Traditionally, wood has been cheap or free and hence widely used in bakery ovens, but deforestation in many countries has resulted in legal restrictions on its use and/or increased costs. It also produces a light fluffy ash that can easily contaminate products. But wherever biomass is the economically best option, efficient technology may help to overcome the environmental problems and health issues.
- Where available, coal is the preferred solid fuel for bakery ovens because it is dense and compact, it has a high calorific (heating) value, it is handled relatively easily and it produces a compact ash that is more easily disposed of than wood ash.
- Charcoal is often more expensive than wood and coal, but it produces an intense heat with little smoke. Having skills and experience to control the fire is more crucial for solid fuels. Variable temperatures causing quality disturbances and wasteful consumption of fuel may lead to increased expenses.
- Liquid fuels such as kerosene or diesel are not widely used in baking ovens because they risk contaminating products with off-odours or even fires and explosions (petrol).
- Solar energy can also be an energy source for baking purposes.

Bakeries Worldwide

Baking is also a lucrative business. In India, there are around 60,000 bakeries, mostly concentrated in the informal sector. The bakery industry is among the few processed food segments whose production has been increasing consistently in the country over the last few years. Baking constitute the largest segment of consumer foods with an annual production of around 4 million tonnes of bakery products (Giz, 2011). In South Africa, approximately 3000 bakeries were registered in 1990 and approximately 80% of the bread production was in the hands of 6 large baking groups. After abolishment of the controlled bread prices in the early 1990's, the number of bakeries increased considerably. In 2005, out of the total of 7900 bakeries, 85 were wholesale bakeries, 600 were in-store corporate bakeries, 3700 were independent bakers, and 3500 were franchise bakers. It is estimated that 53,200 informal bakers operate in non-licensed premises. They offer their baking products to different markets such as domestic, food service establishments, institutions, and wholesale. Unfortunately, the data for Nigeria is unclear and unreliable following the closure of many bakeries from time to time due to unstable economic policies (Giz, 2011).

In terms of the preferred fuel, the heat value of a fuel is considered. The heat value of a fuel is the amount of heat released during its combustion. It is referred to as energy or calorific value. Heat value is a measure of fuel's energy density and is expressed in energy(Joules) per specific amount (eg. Kilogrammes). For instance, the calorific value for :
Liquefied Petroleum Gas(LPG) = 46 – 51MJ/Kg
Firewood(Dry) = 16MJ/Kg (courtesy: World Nuclear Association, England and Wales, 2016 – 2020).

Baker in Uganda (Picture: GIZ Mugerwa)

Statement of the Problem

Gas flaring is the burning of natural gas and petroleum hydrocarbons in flare stacks by upstream oil companies in oil fields during operations. Gas flaring is the singular and most common source of global warming and contributes to emissions of Carbon Monoxide, Nitrogen(II) Oxide and Methane which have the propensity of causing environmental pollution and ecological disturbances or destruction(Ubani & Onyejekwe, 2013). Nigeria is the second largest gas flaring nation in the world(Amanze, 2013).

Okotie and Ikporo(2014), in a study recommended that for every oil field developed in the country, there should be gas handling facility built alongside the oil field development to take care of the gas associated with oil production or they can tie the gas to a nearby compressed gas station(Okotie & Ikporo, 2014). This is with a view to utilizing the gas for generation of electricity, cooking and other domestic uses to enhance the economy of the country. By doing that, the gas emitted would be utilized good economic purposes without posing environmental hazard. Therefore, this study considered how climate change and its associated environmental degradation would be mitigated through the availability and utilization of liquefied Petroleum Gas (LPG), fired baking oven in Enugu State.

Purpose of the Study

The purpose of this study was to determine the extent of availability and utilisation of the Liquified Petroleum Gas (LPG) fired baking oven amongst the bakers within the urban and rural areas of Enugu state; with a view to mitigating the effects of climate change. Specifically, the study attempted to examine:

1. The extent of availability of the Liquified Petroleum Gas (LPG) fired baking oven within the urban and rural areas of Enugu state.
2. The extent of utilisation of the Liquified Petroleum Gas (LPG) fired baking oven amongst bakers in the urban and rural areas of Enugu state.

Research Questions

The following research questions guided the study:

1. To what extent is Liquified Petroleum Gas (LPG) fired baking ovens available within the urban and rural areas of Enugu state?
2. To what extent is the utilisation of Liquified Petroleum Gas (LPG) fired baking oven in the urban and rural areas of Enugu state?

Null Hypotheses

Two null hypotheses formulated by the researcher guided the study.

H_{o1} There is no significant difference in the mean scores of the bakers within the urban and rural areas of Enugu state in respect of the extent of availability of Liquified Petroleum Gas (LPG) fired baking oven.

H_{o2} Significant difference did not exist between the bakers in the urban and rural areas of Enugu state in respect of the extent of utilisation of Liquified Petroleum Gas (LPG) fired baking oven.

Methods

The research design for this study was descriptive survey research design. It was designed to elicit the opinions of a group of bakers in respect of the availability and utilisation of the LPG fired baking oven. The choice of descriptive survey design for the study was apt to enable the respondents give their opinions freely. The descriptive survey also is concerned with collection, collation, analysis, interpretation of data the way they exist without manipulation (Idoko, 2011).

The population comprised 343 bakers in the urban areas and 104 bakers in the rural areas of Enugu state. The entire population was studied. There was therefore, no need for sampling.

The instrument for data collection was a 14-item structured questionnaire. The copies of the instrument were administered at the bakers meeting venues and collected in situ.

The instrument collected were collated. The data so collated were analysed using the mean scores and standard deviations to answer the research questions. The t-test was used to test the null hypotheses to find out if significant difference existed between the mean scores of the urban and rural bakers.

Results

Research Question 1

To what extent is the Liquefied Petroleum Gas (LPG) fired baking oven available within the urban and rural areas of Enugu state?

Table 1

Analysis of Extent of Availability of the LPG fire baking oven for Urban and Rural bakers in Enugu State.

S/No.	Description of items	Mean (x) Urban	Mean (x) Rural	SD Urban	SD Rural	Remarks
1.	LPG fired baking ovens are readily available .	1.7638	1.7692	0.61147	0.67163	LE
2.	The cost is relatively cheap	1.5977	1.5385	0.66771	0.55604	LE
3.	It bakes faster	1.6676	1.8077	0.55174	0.54107	LE
4.	It bakes at commercial rate	1.6764	18942	0.52726	0.36652	LE
5.	Source of fuel(LPG) supply is readily available	1.6210	1.7692	0.53729	0.46698	LE
6.	It attains the desired baking temperature.	1.4490	1.5481	0.54841	0.50009	LE
7.	The calorific value is 3 times higher than firewood.	1.0496	1.0673	0.21736	0.25177	LE
Grand Scores		**= 1.5464**	**1.6277**	**0.5230**	**0.47920**	**LE**

Table 1 above showed that the mean scores range from 1.0496 to 1.8942 which are all below 2.5. Mean scores of less than 2.5 indicate low extent of availability of LPG fired baking oven. At the brink of 2.5, the mean score is moderate extent, but above 2.5 is high extent. Therefore, the result above shows that the level of availability of LPG fired baking oven are to low extent. The standard deviations are all under a unit. Therefore, the mean scores were obtained by the entire class rather than a small number of exceptionally brilliant or dull respondents. Thus the sores are homogeneous and capable of generating normal curve.

Ho_1 Hypothesis

There is no significant difference in the mean scores of the bakers within the urban and rural areas of Enugu state in respect of the extent of availability of Liquified Petroleum Gas (LPG) fired baking oven.

Table 2

t-test analysis of the mean scores of Urban and Rural Bakers on the extent of availability of Liquefied Petroleum Gas (LPG) fired baking oven, in Enugu State

Respondents	Mean	SD	N	Df	t-cal	t-crit	Decision
Urban Bakers	1.5464	0.5230	343	445	3.07	1.64	Significant
Rural Bakers	1.6277	0.4792	104				

Decision: The Calculated value of t (t-cal) was 3.07 which is greater than the critical value of t (t -crit) of 1.64 at 0.05 level of significance. Therefore, we reject the null hypothesis. Hence, Significant difference exists on the extent of availability of the LPG fired Baking Oven in Enugu State

Research Question 2

To what extent is the utilisation of Liquified Petroleum Gas (LPG) fired baking oven in the urban and rural areas of Enugu state?

Table 3

Analysis of Extent of Utilization of the LPG fired baking oven for Urban and Rural bakers in Enugu State.

S/No	Description of items	Mean (x) Urban	Mean (x) Rural	SD Urban	SD Rural	Remarks
1.	The LGP Fired Baking Oven s are readily Utilized by Bakers.	3.8230	1.5865	0.5463	0.56792	ME
2.	It does not pollute the products baked.	3.8280	1.7500	0.64175	0.49757	ME
3.	It is very convenient to use	3.3440	1.7115	0.75588	0.74616	ME
4.	It is prone to fire disaster due to explosion.	3.5685	1.6442	0.77259	0.50084	ME
5.	There is minimal heat loss.	3.5423	1.3846	0.70739	0.57972	ME
6.	Handling is very easy.	3.8017	1.7308	0.64554	0.62676	ME
7.	It does not require large storage space as firewood.	3.5860	1.875	0.66053	0.6425	ME
Grand Scores =		**3.6118**	**1.6346**	**0.6973**	**0.5865**	**ME**

Table 3 above showed that the mean scores range from 1.3846 to 1.875 for the Rural bakers. For the Urban bakers they range from 3.3440 to 3.8280. The mean scores of the Rural bakers indicate low extent of utilization, while that of Urban bakers indicate high extent of utilization of the LPG fired baking oven. On the average, the mean scores of the Urban and Rural bakers indicate moderate extent. Therefore, the result above shows that the level of utilization of LPG fired baking oven are to moderate extent. The standard deviations are all under a unit. Therefore, the mean scores were obtained by the entire class rather than a small number of exceptionally brilliant or dull respondents. Thus the sores are homogeneous and capable of generating normal curve.

H_{o2} Significant difference did not exist between the bakers in the urban and rural areas of Enugu state in respect of the extent of utilisation of Liquified Petroleum Gas (LPG) fired baking oven.

Table 4

t-test analysis of the mean scores of Urban and Rural Bakers on the extent of Utilisation of Liquified Petroleum Gas (LPG) fired baking oven, in Enugu State

Respondents	Mean	SD	N	Df	t-cal	t-crit	Decision
Urban Bakers	3.611	0.6973	343	445	46.63	1.64	Significant
Rural Bakers	1.6346	0.5865	104				

Decision: The calculated value of t (t-cal) was 46.63 which is greater than the critical or table value of t (t-crit) of 1.64 at 0.05 level of significance. Therefore, we reject the null hypothesis. Hence, Significant difference existed in the mean score of Urban and Rural Bakers on the extent of utilization of the LPG fired Baking oven in Enugu State.

Conclusion : The result of the findings showed that significant differences existed in the mean scores of Urban and Rural bakers in respect of both availability and utilization of LPG fired Baking ovens. These findings are in line with the position of Ajuwo, 2013, who was of the view that the LPG Nigeria has been wasting to flaring can be processed and produced into cooking/domestic gas(Ajuwo, 2013). He lamented that Nigeria flares 17.2 billion m^3 of natural gas per year in conjunction with the exploration of crude oil in the Niger Delta(Ajuwo, 2013). In addition to the finding, the calorific value of LPG relative to dry Firewood is far higher; for

instance, Liquified Petroleum Gas(LPG) = 46 – 51MJ/Kg as against Firewood(Dry) = 16MJ/Kg (courtesy: World Nuclear Association, England and Wales, 2016 – 2020). The LPG fired oven is one of the cleanest sources of energy supply for baking/cooking devoid of contamination. This is in line with the submission of (Fellows, 2012 and Lawson, & Joseph, 2009) on the availability of LPG as well as its relative cheaper cost and environmental friendliness.

Recommendations : Following the findings of the study the researchers recommends as hereunder -

1.There is an urgent need to put in place an enforceable legislation that would end gas flaring in the country.

2.An independent government agency should be constituted to ensure the compliance to such legislation.

3.Emerging technologies on oil exploration whereby the petroleum gases can be extracted should be embraced.

4.The Nigeria Gas company should be commercialized to make it more robust in responding to the supply chain of LPG with its potential large market in Nigeria and beyond.

5.The country should domesticate the United Nations Environment Programme (UNEP) environmental protection protocol by preventing deforestation arising from felling of trees for firewood.

6.There is need for an aggressive sensitization of Bakers as well as citizens on the benefits of LPG as a source of energy over firewood.

7. Stringent compensations should be made to communities affected by the acid rain conditions arising from gas flaring to serve as a deterrent to oil companies who still indulge in gas flaring.

8. The entrepreneurial value chain of LPG fired oven is virtually inexhaustible ranging from the exploration of the petroleum gas through the equipment design and fabrication, to bakery proper. If fully exploited, it could be a veritable employment/business opportunities generation channel for micro, small and medium scale enterprises as well as large scale businesses especially within the exploration and distribution segments.

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